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Abstract

NEUTRON MEASUREMENTS INSIDE REACTORS WITH SEMICONDUCTOR COUNTERS*

by

V. Ajdačić, B. Lalović, M. Baručija and *B. Petrović*
Boris Kidrič Institute of Nuclear Sciences, Beograd-Vinča, Yugoslavia

In our earlier papers describing the first counting method, the "long-tube" method, which enables simple and direct measurements of high neutron fluxes inside the reactor core, we dealt with its application to relative measurements. By this method, a 6-meter evacuated aluminum tube which is inserted into the reactor core, is used. A target made of fissile materials, Li^6, or B^{10} is placed at the bottom of the tube. At the other end of the tube, outside the core, a semiconductor counter is mounted to detect fission fragments or heavy particles coming from the target due to neutron induced nuclear reactors. Thus, it was shown that high counting rates of neutron reaction products can be achieved with U^{235}, Pu^{239}, Li^6 and B^{10} targets placed inside the reactor core.

To extend this method to absolute measurements of high neutron fluxes, in the present work we have measured parameters defining the observed yield of reactions. With respect to the effect of particle scattering, special care has been taken in choosing the most suitable geometry of the experiment (target-collimator-counter). An additional aluminum tube with a transistor preamplifier and a semiconductor counter at one end is used to vary the distance between the counter and the target.

The yield of the scattered particles was observed with collimators and counters of different diameters. With a collimator 1 cm in diameter, placed 2 m away from the target we obtained a fission spectrum almost identical with the spectrum usually observed with semiconductor counters. This proved that scattering of fragments from the walls of the tube which previously had caused deformation of fission spectra, was eliminated. By this method and with U^{235} target, absolute measurements of thermal neutron fluxes in the Vinča heavy water moderated reactor operating at 6.5 MW were made. The estimated accuracy of the method was about 4%.

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Possible applications of this method have also been discussed for neutron flux measurements in advanced reactors with super high neutron fluxes (10^{15} - 10^{16} n/cm^2 sec). This application is based on the fact that the counting rate for the given detector position decreases with time, which is caused by the burn-up of the high cross-section target.

Fast neutron spectra inside the Vinča zero-power heavy water moderated reactor have been measured by using semiconductor counters and a Li^6 target. A new detector-target arrangement has been employed, in which only those products of the Li^6 (n, alpha) T reactions whose mutual angle of emission is different from 180° are detected in coincidence. In this way the thermal neutron interference is completely suppressed. Resolution of the spectrometer as a function of the reactor power and correction factors of the spectometer efficiency for various neutron energies are presented. Direct comparison with the sandwich-target geometry shows some advantages of a new detector-target arrangement for measuring fast neutron spectra inside well-moderated low-power assemblies.